



(11)

EP 3 242 027 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

(51) Int Cl.:

(21) Application number: 17169046.4

(22) Date of filing: 02.05.2017

(84) Designated Contracting States:

AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SF SI SK SM TR

Designated Extension States:

Designation
BA ME

Designated Validation States:

Designation
MA MD

(30) Priority: 03.05.2016 KR 20160054908

(71) Applicant: **LG Electronics, Inc.**
Yeongdeungpo-Gu
Seoul 07336 (KR)

(72) Inventors:

- HA, Seongho
08592 Seoul (KR)
- YU, Hyosang
08592 Seoul (KR)
- LIM, Jaeyoun
08592 Seoul (KR)
- CHOI, Kichul
08592 Seoul (KR)
- HEO, Jungwan
08592 Seoul (KR)

(74) Representative: **Vossius & Partner Patentanwälte Rechtsanwälte mbB**
Siebertstrasse 3
81675 München (DE)

(54) LINEAR COMPRESSOR

(57) A linear compressor is provided that may include a casing, a frame accommodated in the casing, a cylinder that passes through a center of the frame, supported by the frame, and defining a compression space for a refrigerant, a piston inserted into the cylinder to reciprocate in an axial direction of the cylinder and having a first end that compresses the refrigerant supplied to the compression space, a suction muffler which is coupled to a second end of the piston and through which the refrigerant supplied to the compression space may flow, a spring that allows a resonant motion of the piston, a back cover including a cover body that defines a refrigerant opening at a central portion, such that a refrigerant passes therethrough, the back cover supporting the spring, and an inflow guide which is fixed to the cover body and guides the refrigerant passing through the refrigerant opening towards an inside of the suction muffler. At least a portion of the inflow guide may be inserted into the suction muffler, and a central axis thereof may be aligned with a central axis of the refrigerant opening.

FIG. 4

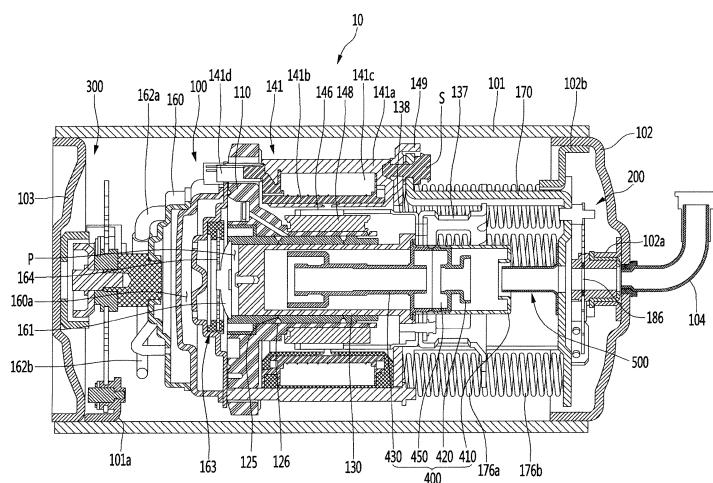
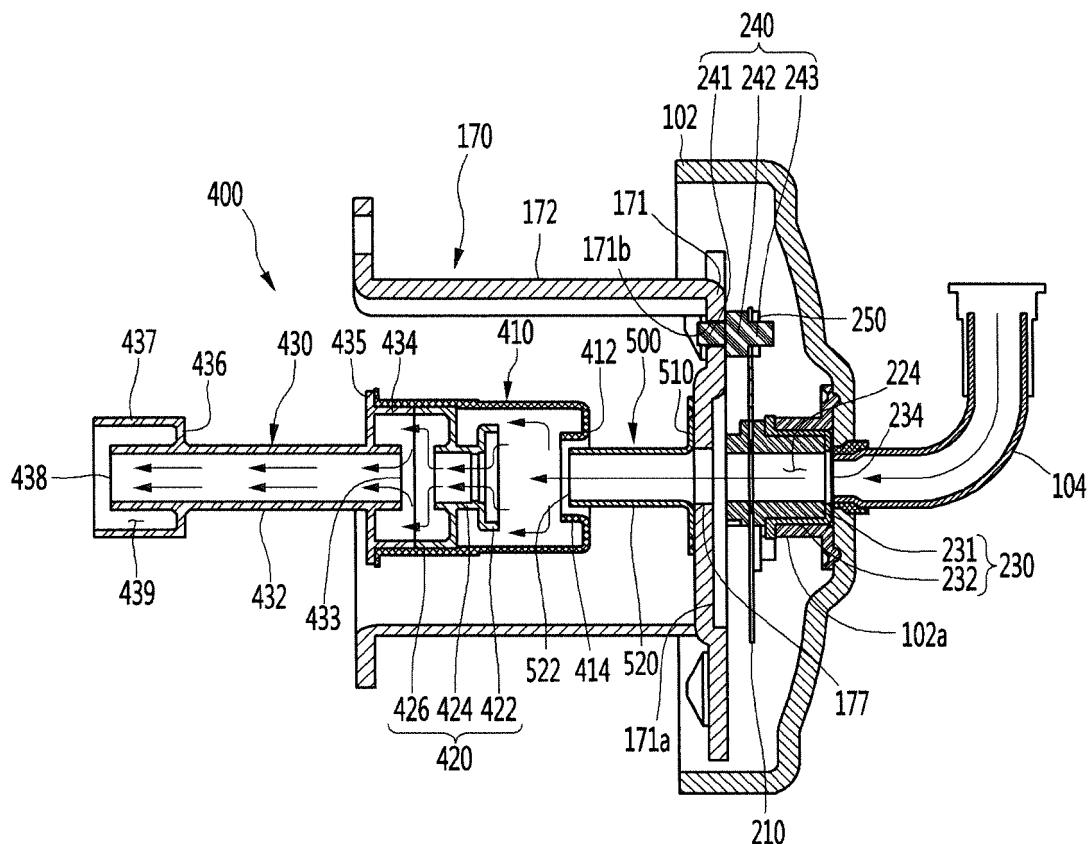


FIG. 6



Description

[0001] A linear compressor is disclosed herein.

[0002] Cooling systems are systems in which a refrigerant circulates to generate cool air. In such a cooling system, processes of compressing, condensing, expanding, and evaporating the refrigerant are repeatedly performed. For this, the cooling system includes a compressor, a condenser, an expansion device, and an evaporator. Also, the cooling system may be installed in a refrigerator or air conditioner which is a home appliance.

[0003] In general, compressors are machines that receive power from a power generation device, such as an electric motor or a turbine, to compress air, a refrigerant, or various working gases, thereby increasing pressure. Compressors are being widely used in home appliances or industrial fields.

[0004] Compressors may be largely classified into reciprocating compressors, in which a compression space into/from which a working gas is suctioned and discharged, is defined between a piston and a cylinder to allow the piston to be linearly reciprocated into the cylinder, thereby compressing a refrigerant, rotary compressors, in which a compression space into/from which a working gas is suctioned or discharged, is defined between a roller that eccentrically rotates and a cylinder to allow the roller to eccentrically rotate along an inner wall of the cylinder, thereby compressing a refrigerant, and scroll compressors, in which a compression space into/from which a refrigerant is suctioned or discharged, is defined between an orbiting scroll and a fixed scroll to compress a refrigerant while the orbiting scroll rotates along the fixed scroll. In recent years, a linear compressor, which is directly connected to a drive motor, in which a piston linearly reciprocates, to improve compression efficiency without mechanical losses due to movement conversion, and having a simple structure, is being widely developed. In general, the linear compressor may suction and compress a refrigerant while a piston linearly reciprocates in a sealed shell by a linear motor and then discharge the refrigerant.

[0005] The linear motor is configured to allow a permanent magnet to be disposed between an inner stator and an outer stator. The permanent magnet may linearly reciprocate by an electromagnetic force between the permanent magnet and the inner (or outer) stator. Also, as the permanent magnet operates in the state in which the permanent magnet is connected to the piston, the permanent magnet may suction and compress the refrigerant while linearly reciprocating within the cylinder and then discharge the refrigerant.

[0006] Korean Patent Publication No. 10-2014-0049403 (hereinafter, referred to as "prior art document"), which was published on April 25, 2014 and is hereby incorporated by reference, discloses a linear compressor. The linear compressor of the prior art document compresses a refrigerant while a piston reciprocates within a cylinder. Oil stored in a shell is supplied to

the cylinder to perform a lubrication action between the piston and the cylinder.

[0007] When the linear compressor is provided in a refrigerator, the linear compressor may be disposed in a machine room which is provided at a rear lower side of the refrigerator. In recent years, a major concern of a customer is of increasing an inner storage space of the refrigerator. To increase the inner storage space of the refrigerator, it may be necessary to reduce a volume of the machine room. Also, to reduce the volume of the machine room, it may be important to reduce a size of the linear compressor.

[0008] However, as the linear compressor disclosed in the prior art document has a relatively large volume, the linear compressor is not adequate for the refrigerator for increasing the inner storage space thereof. To reduce the size of the linear compressor, it may be necessary to reduce a size of a main part or component of the linear compressor. In this case, the linear compressor may be deteriorated in performance.

[0009] To compensate for the deteriorated performance of the linear compressor, it may be considered to increase a drive frequency of the compressor. However, the more the drive frequency of the compressor is increased, the more a friction force due to oil circulating into the compressor increases, deteriorating performance of the compressor.

[0010] The invention is specified in the claims.

[0011] Embodiments disclosed herein provide a linear compressor in which a gas bearing may be applied between a cylinder and a piston, thereby reducing a frictional force generated by oil and reducing a volume thereof. Embodiments disclosed herein also provide a linear compressor capable of preventing a refrigerant gas used as a gas bearing from being introduced again into a cylinder.

[0012] Embodiments disclosed herein provide a linear compressor that may include a casing; a frame accommodated in the casing; a cylinder passing through a center of the frame, supported by the frame, and defining a compression space for a refrigerant; a piston inserted into the cylinder to reciprocate in an axial direction of the cylinder and having one or a first end that compresses the refrigerant supplied to the compression space; a suction muffler which may be coupled to the other or a second end of the piston and through which the refrigerant supplied to the compression space may flow; a spring unit or spring that allows a resonant motion of the piston; a back cover including a cover body that defines a refrigerant opening at a central portion, such that a refrigerant may pass therethrough, the back cover supporting the spring unit; and an inflow guide part or guide which may be fixed to the cover body and guide the refrigerant passing through the refrigerant opening towards an inside of the suction muffler. At least a portion of the inflow guide part may be inserted into the suction muffler, and a central axis thereof may be aligned with a central axis of the refrigerant opening. The inflow guide part may include a

erator, and the base may include a machine room base of the refrigerator. For another example, the product may include an outdoor unit of an air conditioner, and the base may include a base of the outdoor unit.

[0028] The shell 101 may have an approximately cylindrical shape and be disposed to lie in a horizontal direction or an axial direction. In Fig. 1, the shell 101 may extend in the horizontal direction and have a relatively low height in a radial direction. That is, as the linear compressor 10 has a low height, when the linear compressor 10 is installed or provided in the machine room base of the refrigerator, a machine room may be reduced in height.

[0029] A terminal 108 may be installed or provided on an outer surface of the shell 101. The terminal 108 may transmit external power to a motor (see reference numeral 140 of Fig. 3) of the linear compressor 10. The terminal 108 may be connected to a lead line of a coil (see reference numeral 141c of Fig. 3).

[0030] A bracket 109 may be installed or provided outside of the terminal 108. The bracket 109 may include a plurality of brackets that surrounds the terminal 108. The bracket 109 may protect the terminal 108 against an external impact.

[0031] Both sides of the shell 101 may be open. The shell covers 102 and 103 may be coupled to both open sides of the shell 101. The shell covers 102 and 103 may include a first shell cover 102 coupled to one open side of the shell 101 and a second shell cover 103 coupled to the other open side of the shell 101. An inner space of the shell 101 may be sealed by the shell covers 102 and 103.

[0032] In Fig. 1, the first shell cover 102 may be disposed at a first or right portion of the linear compressor 10, and the second shell cover 103 may be disposed at a second or left portion of the linear compressor 10. That is, the first and second shell covers 102 and 103 may be disposed to face each other.

[0033] The linear compressor 10 further includes a plurality of pipes 104, 105, and 106 provided in the shell 101 or the shell covers 102 and 103 to suction, discharge, or inject the refrigerant. The plurality of pipes 104, 105, and 106 may include a suction pipe 104 through which the refrigerant may be suctioned into the linear compressor 10, a discharge pipe 105 through which the compressed refrigerant may be discharged from the linear compressor 10, and a process pipe through which the refrigerant may be supplemented to the linear compressor 10.

[0034] For example, the suction pipe 104 may be coupled to the first shell cover 102. The refrigerant may be suctioned into the linear compressor 10 through the suction pipe 104 in the axial direction. It is apparent that the suction pipe 104 may be coupled to the shell 101 at a position adjacent to the first shell cover 102.

[0035] At least a portion of the suction pipe 104 may be bent upward in a state of being coupled to the first shell cover 102. In this case, when the linear compressor 10 is applied to a refrigerant, a process of coupling pipes

may be facilitated in a machine room of the refrigerant.

[0036] The discharge pipe 105 may be coupled to the shell 101. The refrigerant suctioned through the suction pipe 104 may be compressed while flowing in the axial direction of the shell 101. Also, the compressed refrigerant may be discharged through the discharge pipe 105. The discharge pipe 105 may be disposed at a position which is adjacent to the second shell cover 103 rather than the first shell cover 102.

[0037] Fig. 3 is an exploded perspective view illustrating internal parts or components of the linear compressor according to an embodiment. Fig. 4 is a cross-sectional view, taken along line I-I' of Fig. 1.

[0038] Referring to Figs. 3 and 4, the linear compressor 10 according to an embodiment may include a compressor body 100 and a plurality of support devices or supports that support the compressor body 100 to one or more of the shell 101 and the shell covers 102 and 103.

[0039] The compressor body 100 may include a cylinder 120 provided in the shell 101, a piston 130 that linearly reciprocates within the cylinder 120, and a motor 140 that applies a drive force to the piston 130. The motor 140 may include a linear motor. Therefore, when the motor 140 is driven, the piston 130 may reciprocate in the axial direction of the shell 101.

[0040] The compressor body 100 may further include a suction muffler 400. In detail, the suction muffler 400 may be coupled to the piston 130 to reduce noise generated from the refrigerant suctioned through the suction pipe 104. The refrigerant suctioned through the suction pipe 104 may flow into the piston 130 via the suction muffler 400. For example, while the refrigerant passes through the suction muffler 400, a flow noise of the refrigerant may be reduced.

[0041] The suction muffler 400 may include a plurality of mufflers 410, 420, and 430. The plurality of mufflers 410, 420, and 430 may include a first muffler 410, a second muffler 420, and a third muffler 430, which may be coupled to each other.

[0042] The third muffler 430 may be disposed or provided within the piston 130, and the second muffler 420 may be coupled to a rear portion of the third muffler 430. Also, the first muffler 410 may accommodate the second muffler 420 therein and extend to a rear side of the third muffler 430. In view of a flow direction of the refrigerant, the refrigerant suctioned through the suction pipe 104 may successively pass through the first muffler 410, the second muffler 420, and the third muffler 430. In this process, the flow noise of the refrigerant may be reduced.

[0043] The suction muffler 400 may include a muffler filter 450. The muffler filter 450 may be disposed or provided on or at an interface on or at which the second muffler 420 and the third muffler 430 are coupled to each other. For example, the muffler filter 450 may have a circular shape, and an outer circumferential portion of the muffler filter 450 may be supported between the second and third mufflers 420 and 430.

[0044] The "axial direction" defined herein may be a

central axis direction of the shell 101 and may be understood as a direction (horizontal direction of Fig. 4) in which the piston 130 reciprocates. Also, in the "axial direction", a direction from the suction pipe 104 toward a compression space P, that is, a direction in which the refrigerant flows may be defined as a "forward direction", and a direction opposite to the forward direction may be defined as a "backward direction". On the other hand, the "radial direction" may be understood as a direction which is perpendicular to the radial direction of the shell 101 or the direction (vertical direction of Fig. 4) in which the piston 130 reciprocates. The "axis of the compressor body" means the central line in the axial direction or central longitudinal axis of the piston 130 or the central axis or central longitudinal axis of the shell 101.

[0045] The piston 130 may include a piston body 131 having an approximately cylindrical shape and a piston flange 132 that extends from the piston body 131 in the radial direction. The piston body 131 may reciprocate inside of the cylinder 120, and the piston flange 132 may reciprocate outside of the cylinder 120.

[0046] The cylinder 120 may accommodate at least a portion of the third muffler 430 and at least a portion of the piston body 131. The cylinder 120 has the compression space P in which the refrigerant is compressed by the piston 130. A suction hole 133, through which the refrigerant may be introduced into the compression space P, may be defined in a front portion of the piston body 131, and a suction valve 135 that selectively opens the suction hole 133 may be disposed or provided on or at a front side of the suction hole 133. A coupling hole to which a predetermined coupling member may be coupled may be defined in an approximately central portion of the suction valve 135.

[0047] A discharge cover assembly 160 and a discharge valve assembly 161 and 163 may be provided in or at a front side of the compression space P. The discharge cover assembly 160 may define a discharge space 160a for a refrigerant discharged from the compression space P. The discharge valve assembly 161 and 163 may be coupled to the discharge cover assembly 160 to selectively discharge the refrigerant compressed in the compression space P. The discharge space 160a may include a plurality of space parts or spaces which may be defined by inner walls of the discharge cover assembly 400. The plurality of space parts may be disposed or provided in the forward and rearward direction to communicate with each other.

[0048] The discharge valve assembly 161 and 163 may include a discharge valve 161 and a spring assembly 163. The discharge valve 161 may be opened when a pressure of the compression space P is above a discharge pressure to introduce the refrigerant into the discharge space 401 of the discharge cover assembly 400. The spring assembly 163 may be disposed or provided between the discharge valve 161 and the discharge cover 160 to provide an elastic force in the axial direction.

[0049] The spring assembly 163 may include a valve

spring 163a and a spring support part or support 163b that supports the valve spring 163a to the discharge cover 160. For example, the valve spring 163a may include a plate spring. The spring support part 163b may be integrally injection-molded to the valve spring 163a through an injection-molding process, for example.

[0050] The discharge valve 161 may be coupled to the valve spring 163a, and a rear portion or rear surface of the discharge valve 161 may be disposed to be supported on a front surface of the cylinder 120. When the discharge valve 161 is supported on the front surface of the cylinder 120, the compression space P may be maintained in a sealed state. When the discharge valve 161 is spaced apart from the front surface of the cylinder 120, the compression space P may be opened to discharge the refrigerant compressed in the compression space P.

[0051] The compression space P may be a space defined between the suction valve 135 and the discharge valve 161. The suction valve 135 may be disposed or provided on or at one or a first side of the compression space P, and the discharge valve 161 may be disposed or provided on or at the other or a second side of the compression space P, that is, an opposite side of the suction valve 135.

[0052] While the piston 130 linearly reciprocates within the cylinder 120, when the pressure of the compression space P is below the discharge pressure and a suction pressure, the suction valve 135 may be opened to suction the refrigerant into the compression space P. On the other hand, when the pressure of the compression space P is above the suction pressure, the suction valve 135 may compress the refrigerant of the compression space P in a state in which the suction valve 135 is closed.

[0053] When the pressure of the compression space P is above the discharge pressure, the valve spring 163a may be deformed forward to open the discharge valve 161. The refrigerant may be discharged from the compression space P into the discharge space of the discharge cover 160. When the discharge of the refrigerant is completed, the discharge valve 161 may be closed by a restoring force of the valve spring 163a.

[0054] The compressor body 100 may further include a cover pipe 162a. The cover pipe 162a may be coupled to the discharge cover assembly 160 to discharge the refrigerant flowing through the discharge space 160a of the discharge cover assembly 160. For example, the cover pipe 162a may be made of a metal material.

[0055] The compressor body 100 may further include a loop pipe 162b. The loop pipe 162b may be coupled to the cover pipe 162a to move the refrigerant flowing through the cover pipe 162a to the discharge pipe 105. The loop pipe 162b may have one or a first end coupled to the cover pipe 162a and the other or a second end coupled to the discharge pipe 105.

[0056] The loop pipe 162b may include a flexible material. The loop pipe 162b may roundly extend from the cover pipe 162a along an inner circumferential surface of the shell 101 and be coupled to the discharge pipe

105. For example, the loop pipe 162b may have a wound shape.

[0057] The compressor body 100 may further include a frame 110. The frame 110 may be configured to fix the cylinder 120. For example, the cylinder 120 may be press-fitted into the frame 110.

[0058] The frame 110 may be disposed or provided to surround the cylinder 120. That is, the cylinder 120 may be disposed or provided to be accommodated into the frame 110. Also, the discharge cover 160 may be coupled to a front surface of the frame 110 using a coupling member.

[0059] The frame 110 may define a gas hole 114 for a flow of the refrigerant discharged by the discharge valve 161. The cylinder 120 may define a gas inflow part or inflow 126 through which the gas refrigerant flowing through the gas hole 114 may be introduced.

[0060] The gas inflow part 126 may be recessed inward from an outer circumferential surface of the cylinder 121 in the radial direction. The gas inflow part 126 may have a circular shape along the outer circumferential surface of the cylinder 120 with respect to the central axis in the axial direction.

[0061] The cylinder 120 may further include a cylinder nozzle 125 that extends inward from the gas inflow part 126 in the radial direction. The cylinder nozzle 125 may extend up to the inner circumferential surface of the cylinder 120.

[0062] The refrigerant passing through the cylinder nozzle 125 may be introduced into a space between the inner circumferential surface of the cylinder 120 and the outer circumferential surface of the piston body 131. The gas refrigerant flowing to the outer circumferential surface of the piston body 131 through the cylinder nozzle 125 may provide a lifting force to the piston 130 to perform a function as a gas bearing with respect to the piston 130.

[0063] The compressor body 100 may further include a motor 140. The motor 140 may include an outer stator 141 fixed to the frame 110 and disposed or provided to surround the cylinder 120, an inner stator 148 disposed or provided to be spaced inward from the outer stator 141, and a permanent magnet 146 disposed or provided in a space between the outer stator 141 and the inner stator 148.

[0064] The permanent magnet 146 may be linearly reciprocated by a mutual electromagnetic force between the outer stator 141 and the inner stator 148. Also, the permanent magnet 146 may be provided as a single magnet having one polarity or by coupling a plurality of magnets having three polarities to each other.

[0065] The permanent magnet 146 may be installed or provided on a magnet frame 138. The magnet frame 138 may have an approximately cylindrical shape and be disposed or provided to be inserted into the space between the outer stator 141 and the inner stator 148.

[0066] Referring to the cross-sectional view of Fig. 4, the magnet frame 138 may be coupled to the piston flange 132 to extend in an outer radial direction and then

be bent forward. The permanent magnet 146 may be installed or provided on a front end of the magnet frame 138. When the permanent magnet 146 reciprocates, the piston 130 may reciprocate together with the permanent magnet 146 in the axial direction.

[0067] The outer stator 141 may include coil winding bodies 141b, 141c, and 141d, and a stator core 141a. The coil winding bodies 141b, 141c, and 141d may include a bobbin 141b and a coil 141c wound in a circumferential direction of the bobbin 141b. The coil winding bodies 141b, 141c, and 141d may further include a terminal part or portion 141d that guides a power line connected to the coil 141c so that the power line is led out or exposed to the outside of the outer stator 141.

[0068] The stator core 141a may include a plurality of core blocks in which a plurality of laminations may be laminated in a circumferential direction. The plurality of core blocks may be disposed or provided to surround at least a portion of the coil winding bodies 141b and 141c.

[0069] A stator cover 149 may be disposed or provided on or at one or a first side of the outer stator 141. That is, the outer stator 141 may have one or a first side supported by the frame 110 and the other or a second side supported by the stator cover 149.

[0070] The linear compressor 10 may further include a cover coupling member 149a that couples the stator cover 149 to the frame 110. The cover coupling member 149a may pass through the stator cover 149 to extend forward to the frame 110 and then be coupled to the frame 110.

[0071] The inner stator 148 may be fixed to an outer circumference of the frame 110. Also, in the inner stator 148, the plurality of laminations may be laminated in the circumferential direction outside of the frame 110.

[0072] The compressor body 100 may further include a support 137 that supports the piston 130. The support 137 may be coupled to a rear portion of the piston 130, and the muffler 400 may be disposed or provided to pass through an inside of the support 137. The piston flange 132, the magnet frame 138, and the support 137 may be coupled to each other using a coupling member.

[0073] A balance weight 179 may be coupled to the support 137. A weight of the balance weight 179 may be determined based on a drive frequency range of the compressor body 100.

[0074] According to this embodiment, a friction between the piston and the cylinder is prevented using a gas bearing structure, a drive frequency may be increased while reducing a size of the motor, thereby reducing a size of the whole compressor.

[0075] The compressor body 100 may further include a back cover 170 coupled to the stator cover 149 and extending rearward. The back cover 170 may include three support legs; however, embodiments are not limited thereto. The three support legs may be coupled to a rear surface of the stator cover 149. A spacer 181 may be disposed or provided between the three support legs and a rear surface of the stator cover 149. A distance

from the stator cover 149 to a rear end of the back cover 170 may be determined by adjusting a thickness of the spacer 181. Also, the back cover 170 may be spring-supported by the support 137.

[0076] The compressor body 100 may further include an inflow guide part or guide 500 coupled to the back cover 170 to guide inflow of the refrigerant into the muffler 400. At least a portion of the inflow guide part 500 may be inserted into the suction muffler 400.

[0077] The compressor body 100 may further include a plurality of resonant springs 176a and 176b which may be adjusted in natural frequency to allow the piston 130 to perform a resonant motion. The plurality of resonant springs 176a and 176b may include a first resonant spring 176a supported between the support 137 and the stator cover 149 and a second resonant spring 176b supported between the support 137 and the back cover 170. The piston 130 which reciprocates within the linear compressor 10 may be stably moved by an action of the plurality of resonant springs 176a and 176b to reduce vibration or noise due to movement of the piston.

[0078] The compressor body 100 may further include a plurality of sealing members or seals 127 and 128 that increases a coupling force between the frame 110 and peripheral parts or components around the frame 110. The plurality of sealing members 127 and 128 may include a first sealing member or seal 127 disposed or provided at a portion at which the frame 110 and the discharge cover 160 are coupled to each other. The plurality of sealing members 127 and 128 may further include a second sealing member or seal 128 disposed or provided at a portion at which the frame 110 and the discharge cover 160 are coupled to each other. Each of the first and second sealing members 127 and 128 may have a ring shape.

[0079] The plurality of support devices 200 and 300 may include a first support device or support 200 coupled to one or a first side of the compressor body 100, and a second support device or support 300 coupled to the other or a second side of the compressor body 100. As an axial vibration and a radial vibration of the compressor body 100 may be absorbed by the plurality of support devices 200 and 300, it is possible to prevent the compressor body 100 from directly colliding with the shell 101 or the shell covers 102 and 103.

[0080] Although not limited thereto, the first support device 200 may be fixed to the first shell cover 102, and the second support device 300 may be fixed to the fixing bracket coupled to the inner circumferential surface of the shell 101 at a position adjacent to the second shell cover. On the other hand, the process pipe 106 may be coupled to an outer circumferential surface of the shell 101. A worker may inject the refrigerant into the linear compressor 10 through the process pipe 106. The refrigerant suctioned through the process pipe 106 may be a liquid refrigerant.

[0081] When the refrigerant is injected through the process pipe 106, oil existing in a refrigerant injector

and/or working oil existing in a cooling system may be injected together with the refrigerant. The process pipe 106 may be coupled to the shell 101 at a height different from a height of the discharge pipe 105 so as to avoid interference with the discharge pipe 105. The height is understood as a distance from the leg 50 in the vertical direction (or the radial direction). As the discharge pipe 105 and the process pipe 106 are coupled to the outer circumferential surface of the shell 101 at the heights different from each other, work convenience may be improved.

[0082] Fig. 5 is a perspective view illustrating a back cover and a first shell cover to which a first support device or support is coupled. Fig. 6 is a view illustrating a configuration forming a passage for a refrigerant of a suction pipe to flow into a suction muffler. Fig. 7 is a view illustrating an arrangement relation between an inflow guide part or guide and the suction muffler when a piston is disposed at a top dead center. Fig. 8 is a perspective view of the back cover according to an embodiment. Fig. 9 is a rear view of the back cover according to an embodiment.

[0083] Fig. 6 is a view illustrating an arrangement relation between the inflow guide part and the suction muffler when a piston is disposed or provided at a bottom dead center.

[0084] Referring to Figs. 5 to 9, the back cover 170 may be fixed to the first shell cover 102 by the first support device 200. The suction pipe 104 may be coupled to the first shell cover 102, and the back cover 170 and the first support device 200 may serve to guide the refrigerant suctioned through the suction pipe 104 toward the suction muffler 400.

[0085] The first support device 200 may include the plate spring 210. The plate spring 210 may be fixed to, for example, the back cover 170. The plate spring 210 may be disposed to be erected within the shell 101, such that an axis or central longitudinal axis of the compressor body 100 passes through the center of the plate spring 210.

[0086] The first support device 200 may further include a spring coupling part or portion 220 coupled to the plate spring 210. The spring coupling part 220 may allow the first support device 200 to be easily coupled to the first shell cover 102.

[0087] The first shell cover 102 may include a cover support part or support 102a for coupling of the first support device 200. The cover support part 102a may be integrally formed with the first shell cover 102, or may be coupled to the first shell cover 102.

[0088] The spring coupling part 220 may be inserted into an accommodation part or portion 102c of the cover support part 102a. A buffer part or buffer 230 may be provided between the spring coupling part 220 and the cover support part 102a. Therefore, vibration transferred from the spring coupling part 220 may be absorbed by the buffer part 230, without being transferred to the cover support part 102a. The buffer part 230 may be made of

a material capable of absorbing impact while being deformed by an external force and may be made of, for example, a rubber or a silicon material.

[0089] Although not limited thereto, the buffer part 230 may be fitted into the cover support part 102a, and the spring coupling part 220 may be fitted into the buffer part 230. A cross-section of the accommodation part 102c of the cover support part 102a and a cross-section of the buffer part 230 may be formed to have a non-circular shape such that the buffer part 230 does not relatively rotate with respect to the cover support part 102a. For example the cross-section of the accommodation part 102c of the cover support part 102a and the cross-section of the buffer part 230 may be formed to have a rectangular shape; however, embodiments are not limited thereto.

[0090] Also, a cross-section of a portion of the spring coupling part 220 inserted into the buffer part 230 may be formed to have a non-circular shape such that the spring coupling part 220 does not relatively rotate with respect to the buffer part 230. For example, the cross-section of the spring coupling part 220 inserted into the buffer part 230 may be formed to have a rectangular shape; however, embodiments are not limited thereto.

[0091] The buffer part 230 may include a first contact surface 231 and a second contact surface 232. The first contact surface 231 may contact the spring coupling part 220 in the axial direction so as to absorb axial vibration transferred from the first support device 200. The second contact surface 232 may contact the spring coupling part 220 in the radial direction so as to absorb radial vibration transferred from the first support device 200.

[0092] The second contact surface 232 may surround at least a portion of the spring coupling part 220. The first contact surface 231 may define an opening 234 through which the refrigerant may pass.

[0093] According to this embodiment, the first support device 200 may be coupled to the first shell cover 102, with the buffer part 230 being disposed or provided between the first support device 200 and the first shell cover 102, thereby preventing vibration generated during operation of the linear compressor 10 from being transferred to the shell 101 by the first shell cover 102.

[0094] In this embodiment, axial vibration of the compressor body 100 may be absorbed by the plate spring 210 and radial vibration may be absorbed by the buffer part 230, thereby minimizing a phenomenon that vibration of the compressor body 100 is transferred to the shell 101 by the first shell cover 102.

[0095] The spring coupling part 220 may include a refrigerant passage 224 through which the refrigerant suctioned through the suction pipe 104 may pass. For example, the refrigerant passage 224 may be aligned with the opening 234 of the buffer part 230 in a state in which the spring coupling part 220 is fitted into the buffer part 230. The spring coupling part 220 may be integrally formed with the plate spring 210 by insert injection molding, for example.

[0096] The plate spring 210 may be coupled to the back

cover 170 by a back cover coupling member 240. The back cover coupling member 240 may include a cover insertion part or portion 241 that passes through a coupling hole 171 b of the back cover 170, a contact part or contact 242 that contacts the back cover 170, and a spring insertion part or portion 243 that passes through the first plate spring 210.

[0097] A diameter of the contact part 242 may be greater than a diameter of each of the cover insertion part 241 and the spring insertion part 243. Therefore, when the contact part 242 contacts the back cover 170 in a state in which the cover insertion part 241 passes through the coupling hole 171 b of the back cover 170, the plate spring 210 and the back cover 170 may be spaced a predetermined distance from each other.

[0098] In a state in which the spring insertion part 233 passes through the plate spring 210, a washer 250 may be coupled to the spring insertion part 243 so as to prevent the plate spring 210 from being released from the back cover coupling member 240.

[0099] The back cover 170 may include a cover body 171 that defines the coupling hole 171b, and a plurality of coupling legs 172 that extends from the cover body 171 toward the motor 140. Each of the coupling legs 172 may include a coupling part or portion 173 that couples to the stator cover 149. The coupling part 173 extends from the coupling leg 172 in the radial direction of the compressor body 100.

[0100] The coupling part 173 may define a coupling hole 173a to which a coupling member S may be coupled. The coupling member S may pass through the coupling hole 173a of the coupling part 173 and be coupled to the stator cover 149.

[0101] A recess part or recess 171 a may be formed in the cover body 171. The recess part 171 a may be recessed from the cover body 171 toward the piston 130. As illustrated in Fig. 6, the spring coupling part 220 may be spaced apart from the recess part 171 a when the compressor body 100 is not operated by the recess part 171 a.

[0102] When the compressor body 100 moves toward the spring coupling part 220 (a rightward direction in Fig. 6) due to axial vibration of the compressor body 100, if the recess part 171 a contacts the spring coupling part 220, the compressor body 100 does not move in a rightward direction any more. Therefore, a moving distance in the axial direction of the compressor body 100 is reduced, thereby preventing the plate spring 210 from being excessively deformed.

[0103] The recess part 171 a may be formed in the cover body 171 so as to limit the axial movement of the compressor body 100 while preventing an increase in length in the axial direction of the linear compressor 10. When the state in which the spring coupling part 220 contacts the recess part 171 a is maintained, there is a problem that noise is great due to friction between the recess part 171 a and the spring coupling part 220 during vibration of the compressor body 100, and there is a prob-

lem that the compressor body 100 does not stably perform a resonant motion. Therefore, the spring coupling part 220 may maintain a state of being spaced apart from the recess part 171 a when the compressor body 100 is not operated by the recess part 171 a.

[0104] The recess part 171 a may define a refrigerant opening 177 through which the refrigerant flowing along the refrigerant passage 224 of the spring coupling part 220 passes. Further, the recess part 171 a may be formed to have an approximately triangular shape as shown in Fig. 9. The recess part 171 a may serve to improve a strength of the cover body 171, and a portion of the recess part 171 a may be disposed or provided between two adjacent back cover coupling holes 171b so as to maximize strength improvement.

[0105] The back cover 170 may further include a plurality of spring support parts or supports 174. The plurality of coupling legs 172 and the plurality of spring support parts 174 may be alternately arranged. The second resonant spring 176b may be supported to or by each of the plurality of spring support parts 174. A coupling protrusion 174a to be coupled to the second resonant spring 176b may be provided in or for each of the plurality of spring support parts 174.

[0106] The inflow guide part 500 may be fixed to the back cover 170. The inflow guide part 500 may include a guide pipe 520 that guides the flow of the refrigerant, and a flange part or flange 510 that extends from one or a first end of the guide pipe 520 in the radial direction.

[0107] The flange part 510 may be fixed to the cover body 171. The flange part 510 may be fixed to the cover body 171 by, for example, fusion or welding.

[0108] The flange part 510 may be fixed to the cover body 171 so as to come into surface contact with the cover body 171 in the axial direction of the compressor body 100. As the flange part 510 may be fixed to the cover body 171, a coupling force between the inflow guide part 500 and the back cover 170 may be improved. Also, it is possible to prevent the inflow guide part 500 from being separated from the back cover 170 during vibration of the compressor body 100.

[0109] The flange part 510 may be fixed to the cover body 171 in a state in which a center of the guide pipe 520 and a center of the refrigerant opening 177 of the cover body 171 are aligned so as to be coaxial.

[0110] The guide pipe 520 may maintain a state of being inserted into the suction muffler 150 when operation of the compressor body 100 is stopped. At this time, as the guide pipe 520 extends from the recess part 171, a length of the guide pipe 520 may be reduced. If the length of the guide pipe 520 is reduced, a weight of the inflow guide part 500 may be reduced and thus a total weight of the compressor itself may be reduced. The length of the coupling leg may be formed to be greater than the length of the guide pipe 520, such that the guide pipe 520 does not interfere with the suction muffler 400 within the suction muffler 400 and the coupling leg 172 is coupled to the stator cover 149.

[0111] As described above, the suction muffler 400 may include first to third mufflers 410, 420, and 430. The first muffler 410 may have an approximately cylindrical shape. The first muffler 410 may define an opening 412 through which the guide pipe 520 may pass. A refrigerant outlet 522 of the guide pipe 520 may pass through the opening 412 and be inserted into the first muffler 410. A diameter of the opening 412 through which the guide pipe 520 may pass may be greater than an external diameter of the guide pipe 520.

[0112] The first muffler 410 may further include a blocking sleeve 414 that blocks the refrigerant introduced into the first muffler 410 from being discharged to the outside through the opening 412. That is, the blocking sleeve 414 blocks the refrigerant in the first muffler 410 from flowing into the opening 412.

[0113] The blocking sleeve 414 may extend, for example, from an edge of the opening 412 toward the second muffler 420. The blocking sleeve 414 may have, for example, a cylindrical shape.

[0114] Therefore, the guide pipe 520 may be disposed or provided inside of the blocking sleeve 414. An internal diameter of the blocking sleeve 414 may be formed to be greater than an external diameter of the guide pipe 520, such that the blocking sleeve 414 and the guide pipe 520 are spaced apart from each other.

[0115] The blocking sleeve 414 and the guide pipe 520 may be spaced apart from each other, so as to reduce noise generated by friction between the blocking sleeve 414 and the guide pipe 520 during vibration of the compressor body 100. If the compressor body 100 is operated in a state in which the blocking sleeve 414 and the guide pipe 520 are in a contacted state, there is a problem that the noise caused by the friction between the blocking sleeve 414 and the guide pipe 520 increases. Also, during radial vibration of the compressor body 110, the guide pipe 520 may be deformed or the inflow guide part 520 may be separated from the back cover 170. Therefore, according to embodiments disclosed herein, the blocking sleeve 414 may be separated from the guide pipe 520.

[0116] According to this embodiment, gas supplied into the cylinder 120 through the cylinder nozzle (see reference numeral 125 of Fig. 4) to act as the gas bearing may be discharged toward a rear side of the cylinder 120 (a rightward direction in Fig. 4). The gas supplied into the cylinder 120 is a high-temperature gas. If the high-temperature gas is introduced into the suction muffler 150, suction loss occurs, and thus, power consumption of the linear compressor 10 increases.

[0117] According to embodiments disclosed herein, as the guide pipe 520 of the inflow guide part 500 fixed to the back cover 170 may be disposed or provided inside of the first muffler 410 through the opening 412 of the first muffler 410, it is possible to minimize a phenomenon that the high-temperature gas discharged from the cylinder 120 to the shell 101 is introduced into the opening 412 of the first muffler 410. That is, as the high-temperature gas acts as a resistor in the opening 412 of the first

muffler 410, the guide pipe 520 may minimize introduction of the gas.

[0118] Further, as the blocking sleeve 414 is formed to have a cylindrical shape with a certain length and the guide pipe 520 may be disposed or provided in an inner space of the blocking sleeve 414, it is possible to further prevent the high-temperature gas from passing between the blocking sleeve 414 and the guide pipe 520. Furthermore, as the blocking sleeve 414 has a cylindrical shape to surround the guide pipe 520, the guide pipe 520 and the blocking sleeve 414 come into surface contact with each other when the guide pipe 520 and the blocking sleeve 414 contact each other due to radial vibration of the compressor body 100. Therefore, the blocking sleeve 414 and the guide pipe 520 may be rapidly aligned in the horizontal direction.

[0119] According to embodiments disclosed herein, the piston 130 may reciprocate between a bottom dead center and a top dead center as shown in Figs. 6 and 7. When the piston 130 reciprocates between the bottom dead center and the top dead center, it is possible to maintain the state in which the guide pipe 510 and the blocking sleeve 414 overlap each other in the radial direction. That is, when the piston 130 is positioned at the bottom dead center and when the piston 130 is positioned at the top dead center, it is possible to maintain the state in which the guide pipe 510 and the blocking sleeve 414 overlap each other in the radial direction.

[0120] Even when the piston 130 moves from the top dead center (Fig. 7) to the bottom dead center (Fig. 6), the length of the guide pipe 520 inserted into the first muffler 410 increases. In order to prevent the guide pipe 520 from interfering with the second muffler 420, a front end of the guide pipe 520 may be spaced apart from a rear end of the second muffler 420 in a state in which the piston 130 is positioned at the bottom dead center.

[0121] The second muffler 420 may be accommodated in the first muffler 410. The second muffler 420 may be accommodated in the first muffler 410 at an opposite side of the opening 412 of the first muffler 410.

[0122] The second muffler 420 may include a first flow part or portion 422 for introduction of the refrigerant introduced in the first muffler 410, a second flow part or portion 424 that extends from the first flow part 422 toward the piston 130, and a first contact part or contact 426 that extends outward from the first flow part 424 and contacts an inner circumferential surface of the first muffler 410.

[0123] An internal diameter of a portion of the first muffler 410 may be equal to an external diameter of the first contact part 426 of the second muffler 420. An internal diameter of another portion of the first muffler 410 may be less than the external diameter of the first contact part 426 of the second muffler 420 so as to restrict an insertion depth of the second muffler 420.

[0124] An inlet diameter of the first flow part 422 may be formed to be less than an internal diameter of the first muffler 410. An inlet diameter of the first flow part 422

may be formed to be greater than an internal diameter of the blocking sleeve 414.

[0125] Therefore, a flow cross-sectional area increases in a process in which the refrigerant discharged from the guide pipe 520 flows from the space inside of the first muffler 410 to the first flow part 422. Consequently, a flow velocity may be reduced, and thus, noise may be reduced.

[0126] The third muffler 430 may be inserted into the first muffler 410 at an opposite side of the opening 412 of the first muffler 410 in a state in which the second muffler 420 is inserted into the first muffler 410. The third muffler 430 may include a refrigerant flow pipe 432 through which the refrigerant flowing through the second muffler 420 may be introduced, a flange 435 that extends from the refrigerant flow pipe 432, and a second contact part or contact 434 that extends from the flange 435 and contacts an inner surface of the first muffler 410.

[0127] An external diameter of the flange 435 may be greater than an external diameter of the second contact part 434. The external diameter of the flange 435 may be greater than the internal diameter of the first muffler 410. Therefore, as the flange 435 contacts the outer surface of the first muffler 410 when the second contact part 434 is inserted into the first muffler 410, it is possible to restrict an insertion depth of the second contact part 434.

[0128] A diameter of the opening 433 of the refrigerant flow pipe 432 may be less than an internal diameter of the first contact part 426 and the second contact part 434. The refrigerant flow pipe 432 may be spaced apart from the second flow part 424 of the second muffler 420.

[0129] Therefore, a flow cross-sectional area may increase in a process in which the refrigerant discharged from the second flow part 424 of the second muffler 420 flows to the refrigerant flow pipe 432. Consequently, a flow velocity may be reduced, and thus, noise may be reduced.

[0130] The third muffler 430 may include a first extension part or extension 436 that extends from an outer circumferential surface of the refrigerant flow pipe 432 in the radial direction, and a second extension part or extension 437 that extends in a direction away from the first extension part 436 to the second muffler 420. The first extension part 436 and the second extension part 437 may define a storage space 439 to store at least a portion of the refrigerant suctioned into the compression space P.

[0131] At least a portion of the refrigerant discharged from the outlet 438 of the refrigerant flow pipe 432 may flow backward toward the flange 435 of the third muffler 430 through a space between the piston 130 and the refrigerant flow pipe 432, or may form swirl in a space around the outlet 438 of the refrigerant flow pipe 432. In particular, as an amount of refrigerant suctioned into the compression space P increases, such flow occurs more frequently. A backward flow or swirl of the refrigerant may deteriorate a refrigerant suction efficiency.

[0132] As the storage space 439 stores a portion of

the refrigerant discharged from the refrigerant flow pipe 432, it is possible to perform a function of preventing the backward flow or swirl of the refrigerant at a front end (outlet end portion) of the refrigerant flow pipe 432. Also, the refrigerant stored in the storage space 439 may experience a compression and discharge process after the suction of the refrigerant is completed, and then be suctioned into the compression space P in the next refrigerant suction process.

[0133] The first extension part 436 may be disposed or provided at a position which is closer to the suction hole (see reference numeral 133 of Fig. 3) of the piston 130 rather than the outlet 438 of the refrigerant flowpipe 432. Therefore, an area of the storage space 439 may increase, and thus, a larger amount of refrigerant may be stored. 10

[0134] As described above, the flow of the refrigerant may be controlled by forming the storage space 439 at a position which is adjacent to the outlet 439 of the refrigerant flow pipe 432, thereby improving the refrigerant suction efficiency. 20

[0135] According to embodiments disclosed herein, as friction between the piston and the cylinder is prevented using the gas bearing structure, a drive frequency may be increased while reducing a size of a motor, thereby reducing a size of a whole compressor. Further, as the inflow guide part is provided in the back cover and is positioned inside the suction muffler, the high-pressure gas used as the gas bearing may be introduced into the suction muffler, thereby minimizing deterioration of a suction efficiency. Furthermore, due to the blocking sleeve, the gas introduced into the suction muffler may be prevented from flowing backward to the outside of the suction muffler. 25

[0136] Also, as the inflow guide part may be coupled to the recess part of the cover body constituting the back cover, a length of the inflow guide part may be reduced. Additionally, the inflow guide part may include the guide pipe and the flange, and the flange may be coupled to the cover body of the back cover, thereby improving a coupling force between the inflow guide part and the back cover. 30

[0137] Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments. 40

Claims

1. A linear compressor, comprising:

5 a casing;
a frame (110) accommodated in the casing;
a cylinder (120) that passes through a center of the frame (110), is supported by the frame, and defines a compression space (P) for a refrigerant;
a piston (130) inserted into the cylinder (120) to reciprocate in an axial direction of the cylinder (120) and having a first end that compresses the refrigerant supplied to the compression space (P);
a suction muffler (400) coupled to a second end of the piston and through which the refrigerant supplied to the compression space (P) flows;
at least one spring (176a, 176b) that allows a resonant motion of the piston (130);
a back cover (170) including a cover body (171) that defines a refrigerant opening at a central portion, such that the refrigerant passes therethrough, wherein the back cover (170) supports the at least one spring; and
an inflow guide (500) which is fixed to the cover body (171) and guides the refrigerant passing through the refrigerant opening towards an inside of the suction muffler (400), wherein at least a portion of the inflow guide (500) is inserted into the suction muffler (400), and a central longitudinal axis of the inflow guide (500) is aligned with a central longitudinal axis of the refrigerant opening.

2. A linear compressor, comprising:

a casing;
a frame (110) accommodated in the casing;
a cylinder (120) that passes through a center of the frame (110), is supported by the frame (110), and defines a compression space (P) for a refrigerant;
a piston (130) inserted into the cylinder (120) to reciprocate in an axial direction of the cylinder (120) and having a first end that compresses the refrigerant supplied to the compression space (P);
a suction muffler (400) coupled to a second end of the piston (130) and through which the refrigerant supplied to the compression space (P) flows;
at least one spring (176a, 176b) that allows a resonant motion of the piston (130);
a back cover (170) including a cover body (171) that defines a refrigerant opening at a central portion, such that the refrigerant passes therethrough, wherein the back cover (170) supports

the at least one spring; and
an inflow guide (500) that guides the refrigerant passing through the refrigerant opening towards an inside of the suction muffler (400), wherein at least a portion of the inflow guide (500) is inserted into the suction muffler (400), and wherein the inflow guide (500) and the refrigerant opening are coaxial.

3. The linear compressor according to claim 1 or 2, wherein the inflow guide (500) includes:

a guide pipe (520) that extends a predetermined length so as to be inserted into the suction muffler (400); and
a flange (510) which is bent at a rear end of the guide pipe (520) and contacts the cover body.

4. The linear compressor according to claim 3, further including a support (200) that supports the back cover (170) and fixes the back cover (170) to the casing, wherein a recess (171 a) which is recessed towards the piston (130) is formed at an inner side of the cover body (171), and wherein the flange (510) is coupled to the back cover (170) at a surface opposite to the recess (171a).

5. The linear compressor according to claim 4, wherein the support (200) includes:

a plate spring (210) fixed to the cover body (171) at a side opposite to the inflow guide (500); and
a spring coupling portion (220) coupled to a center of the plate spring (210), wherein a refrigerant passage is defined inside of the spring coupling portion (220).

6. The linear compressor according to claim 5, wherein the spring coupling portion (220) is maintained in a state of being spaced apart from the recess (171 a), and wherein, when the back cover (170) vibrates toward the spring coupling portion (220), the spring coupling portion (220) contacts the recess (171 a) due to deformation of the plate spring (210).

7. The linear compressor according to claim 5, wherein a center of the guide pipe (520), a center of the refrigerant opening, and a center of the refrigerant passage are aligned on a same line.

8. The linear compressor according to claim 3, further including:

a motor that provides power to the piston; and
a stator cover (149) that supports the motor together with the frame (110), wherein the back cover (170) includes:

5

a plurality of spring supports (174) that extends from an edge of the cover body (171) in a radial direction and supports the at least one spring;

a plurality of coupling legs (172) which is bent at an edge of the cover body (171) and extends a predetermined length toward the stator cover (149), wherein each of the plurality of coupling legs (172) extends to be longer than the guide pipe (520).

15

9. The linear compressor according to claim 3, wherein the suction muffler includes:

an opening through which the guide pipe (520) passes; and
a blocking sleeve (414) that extends from an edge of the opening toward the piston (130).

20

10. The linear compressor according to claim 9, wherein an internal diameter of the blocking sleeve (414) is greater than an external diameter of the guide pipe (520).

25

11. The linear compressor according to claim 9, wherein the suction muffler includes:

a first muffler (410) in which the opening and the blocking sleeve are formed at a first end thereof; a second muffler (420) accommodated into the first muffler (410) and including a flow portion (422) through which the refrigerant passing through the guide pipe (520) flows, wherein an inlet diameter of the flow portion is greater than an internal diameter of the blocking sleeve (414).

30

12. The linear compressor according to claim 11, further including a third muffler (430) having a first end inserted into a second end of the first muffler (410) and coupled to the second muffler (420), wherein a second end of the third muffler (430) is accommodated in the piston (130).

35

13. The linear compressor according to claim 12, wherein the third muffler (430) includes:

a refrigerant flow pipe (432) through which the refrigerant flows;
a first extension (436) extends from an outer circumferential surface of the refrigerant flow pipe (432) in a radial direction; and
a second extension (437) bent from the first extension (436) and extending in a direction away from the second muffler (420), wherein an end of the second extension (437) is disposed to be more in front than an outlet of the refrigerant flow pipe (432).

40

45

50

55

FIG. 1

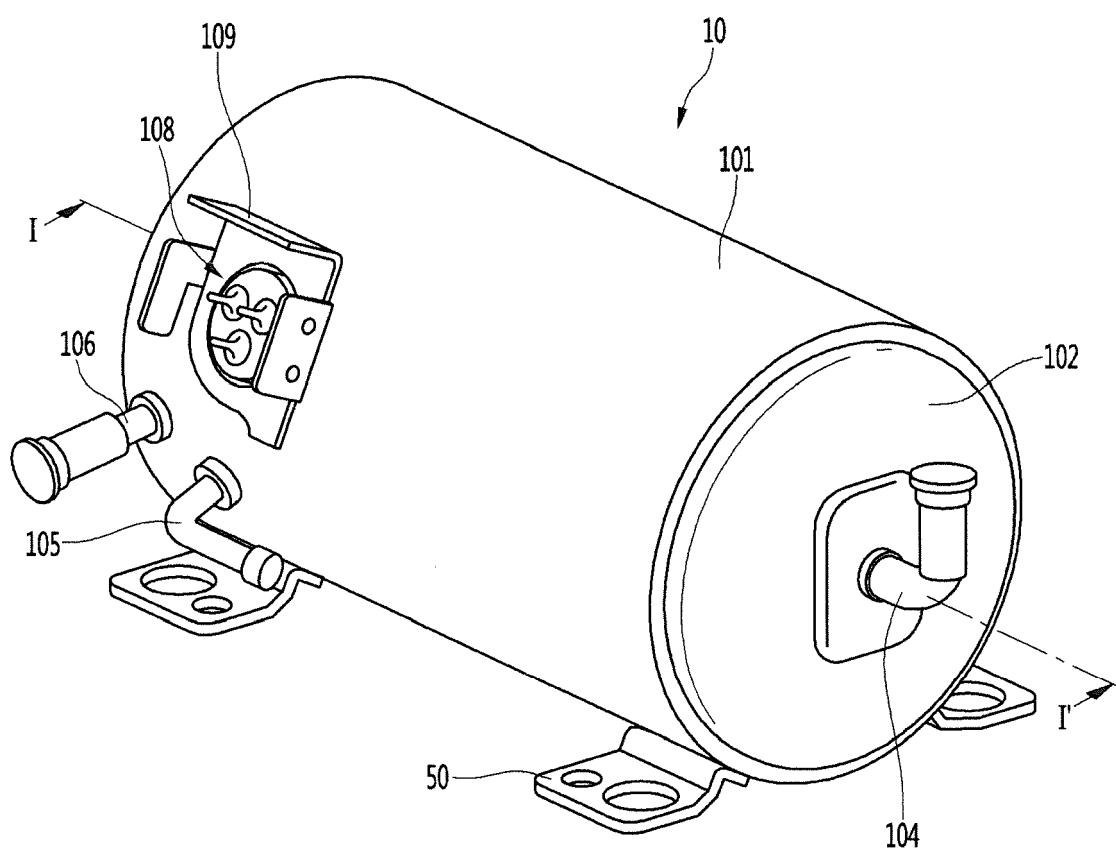


FIG. 2

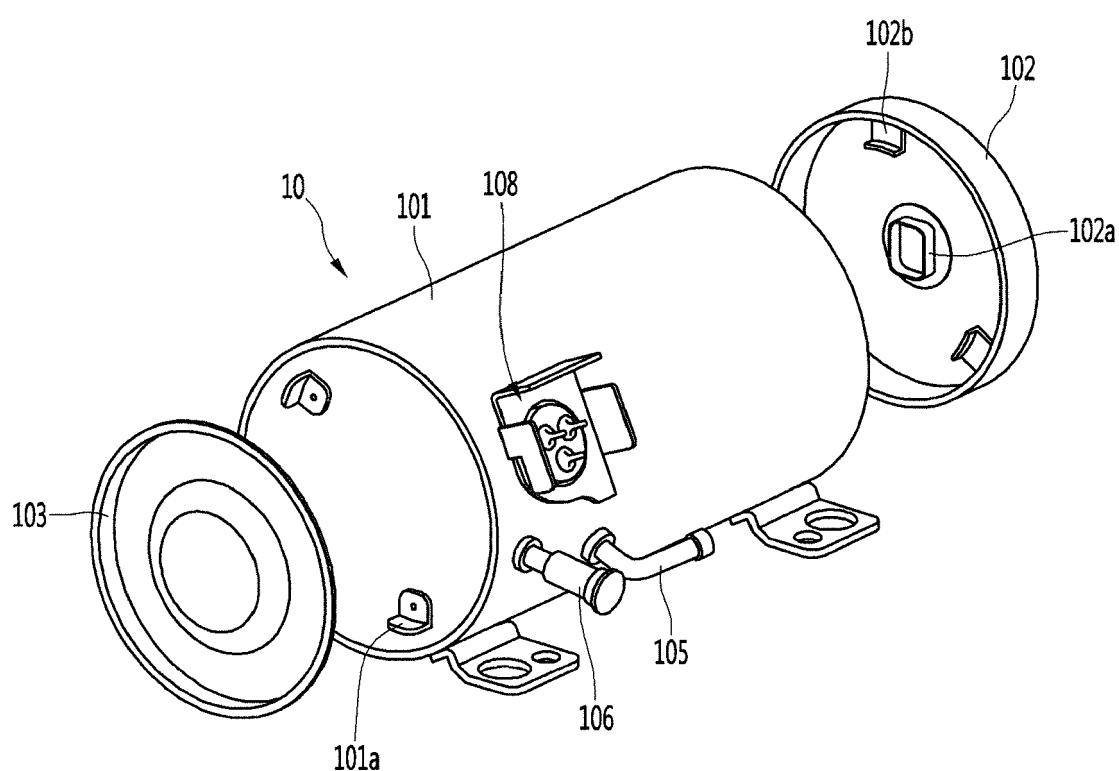


FIG. 3

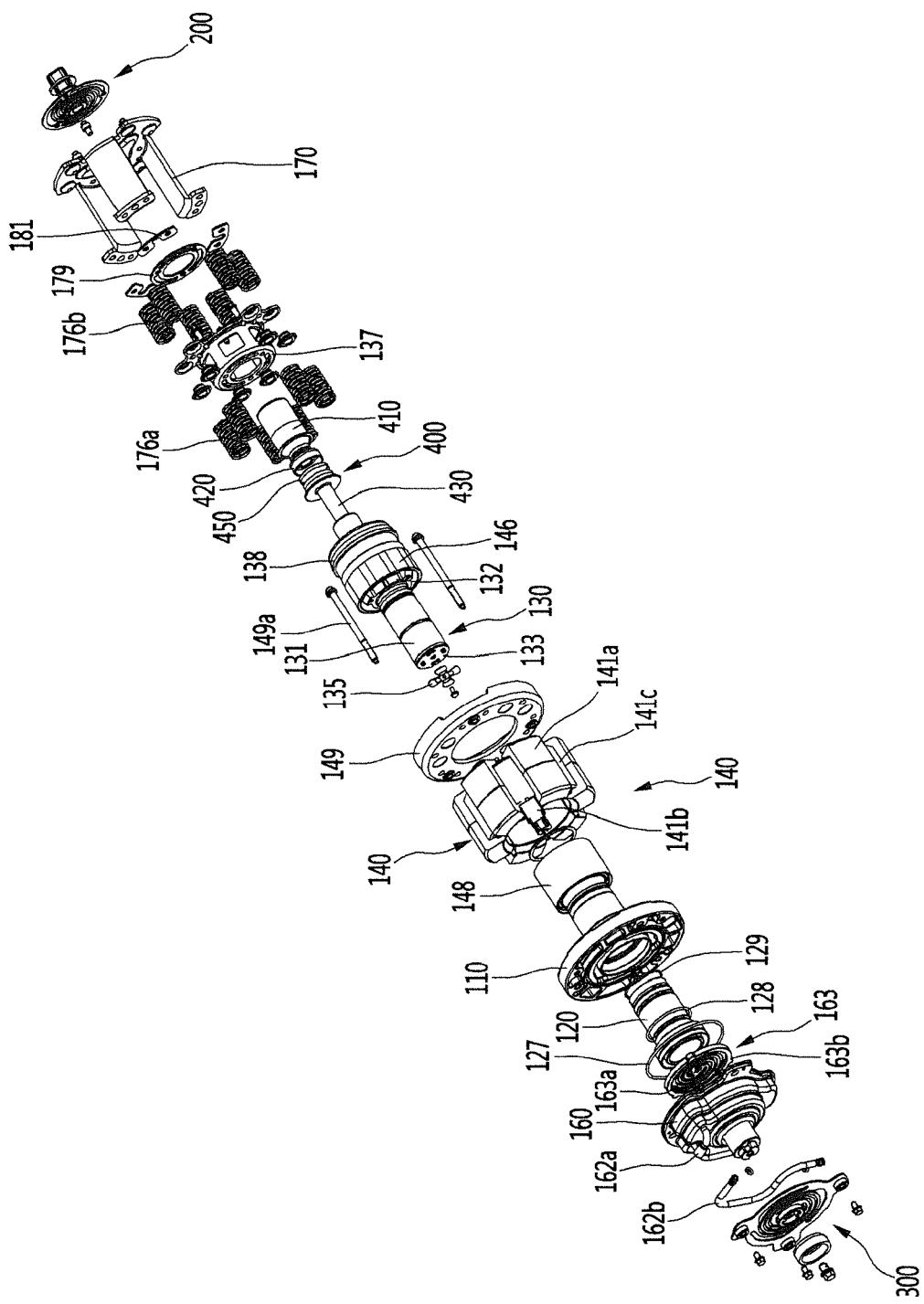


FIG. 4

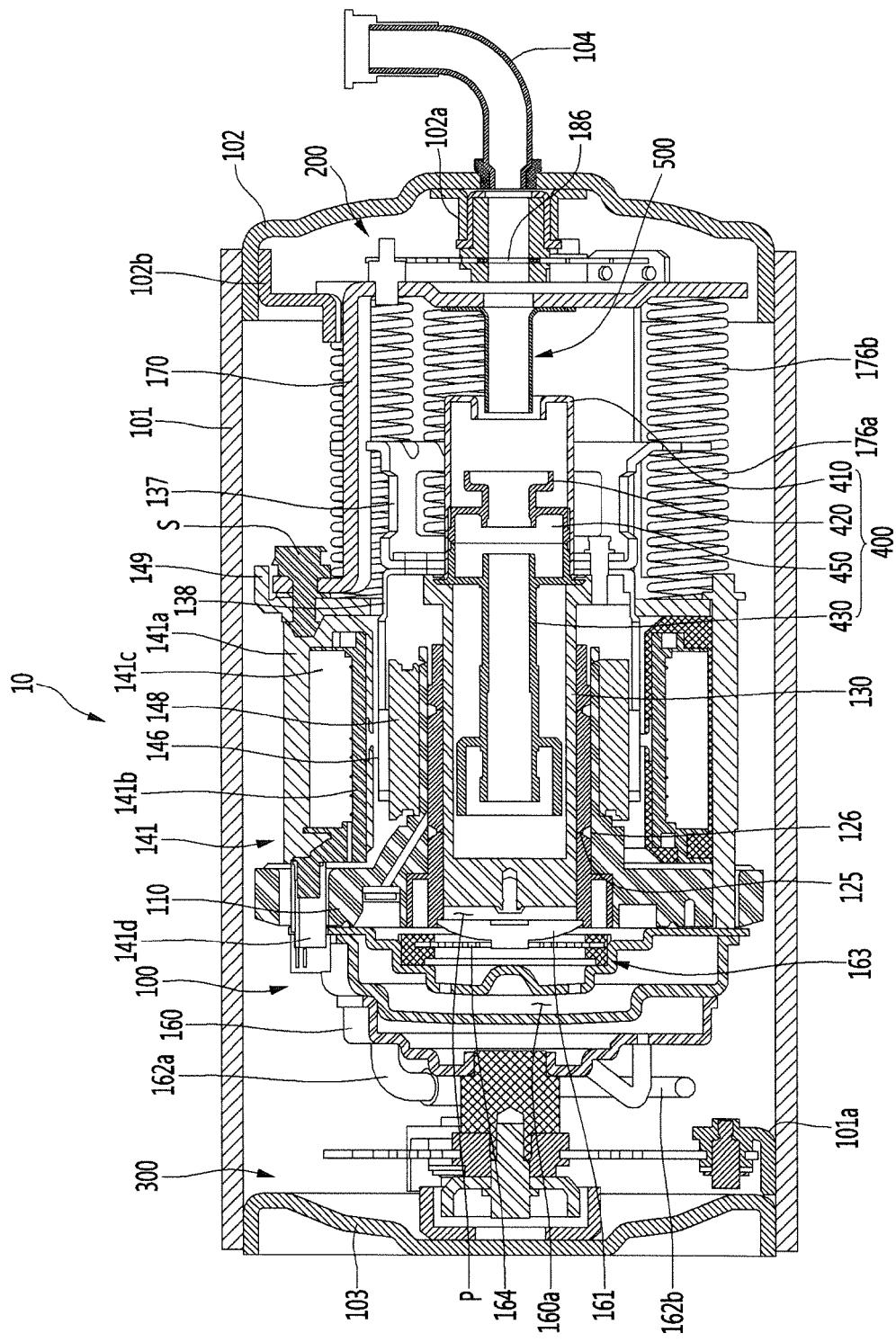


FIG. 5

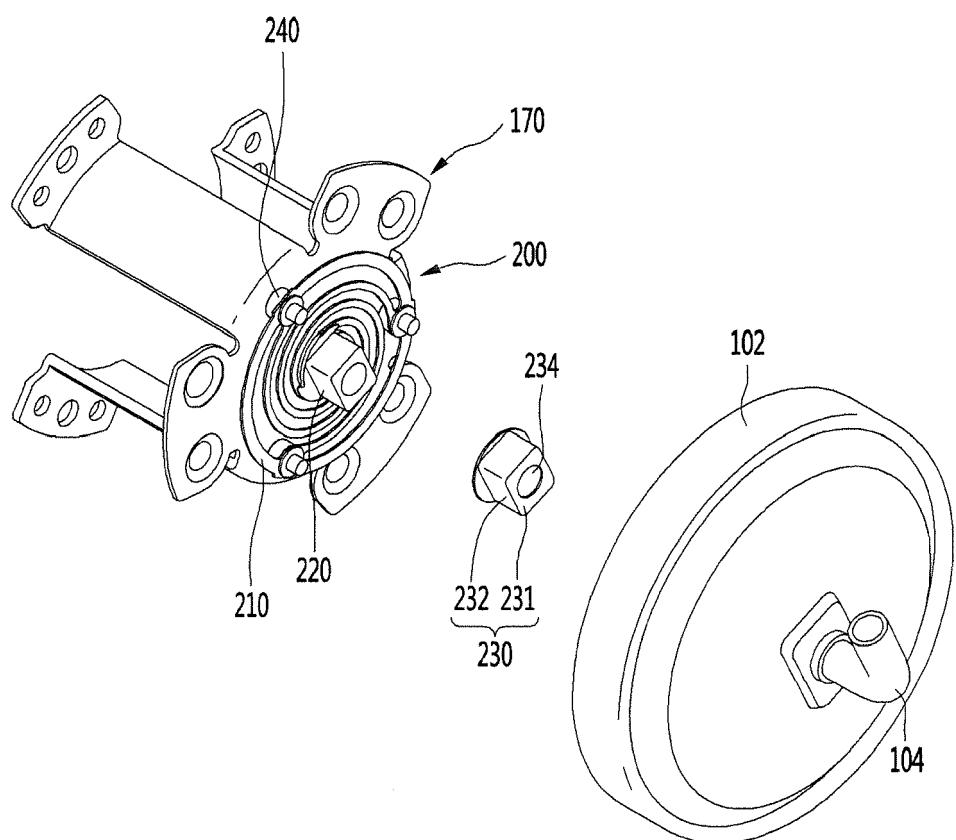


FIG. 6

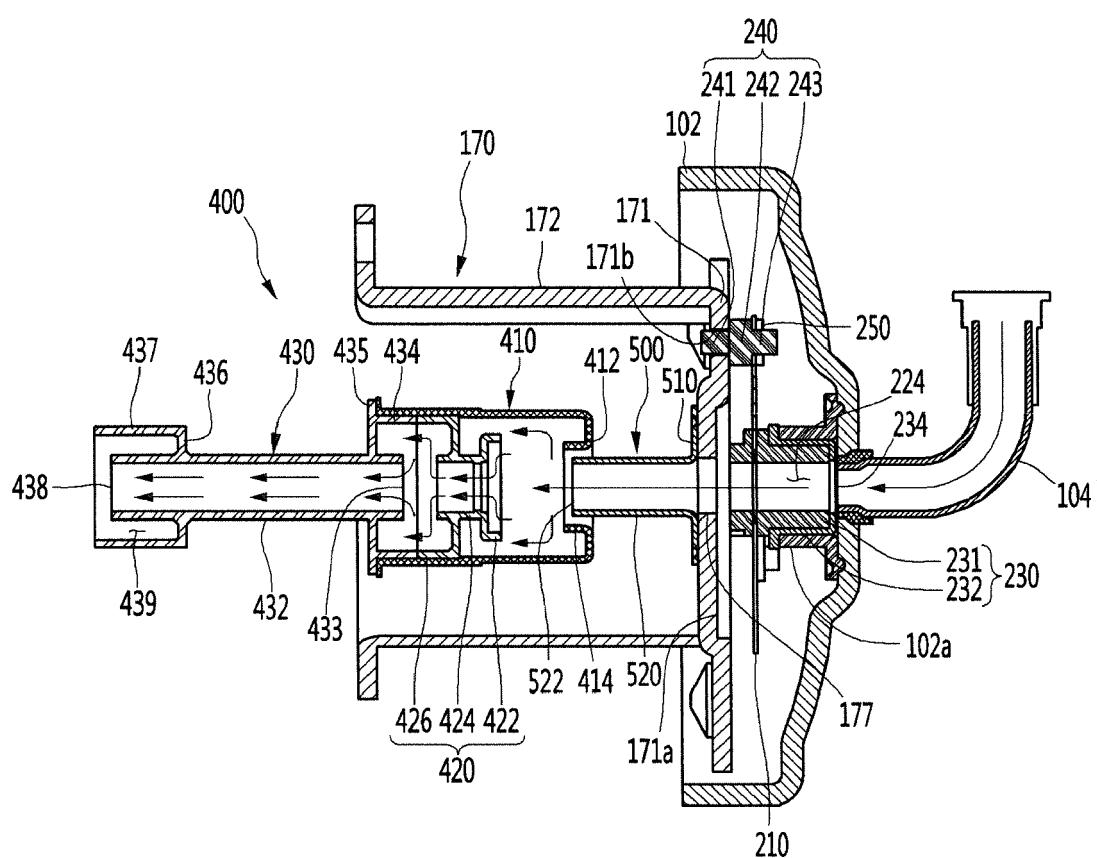


FIG. 7

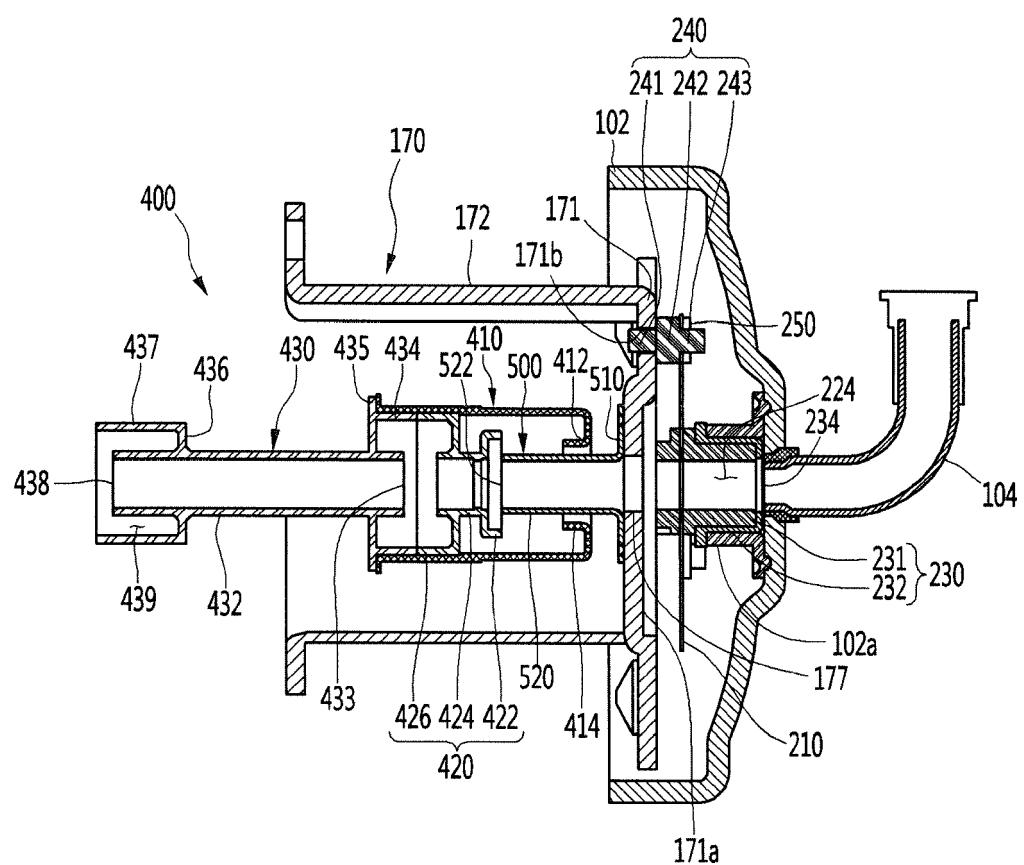


FIG. 8

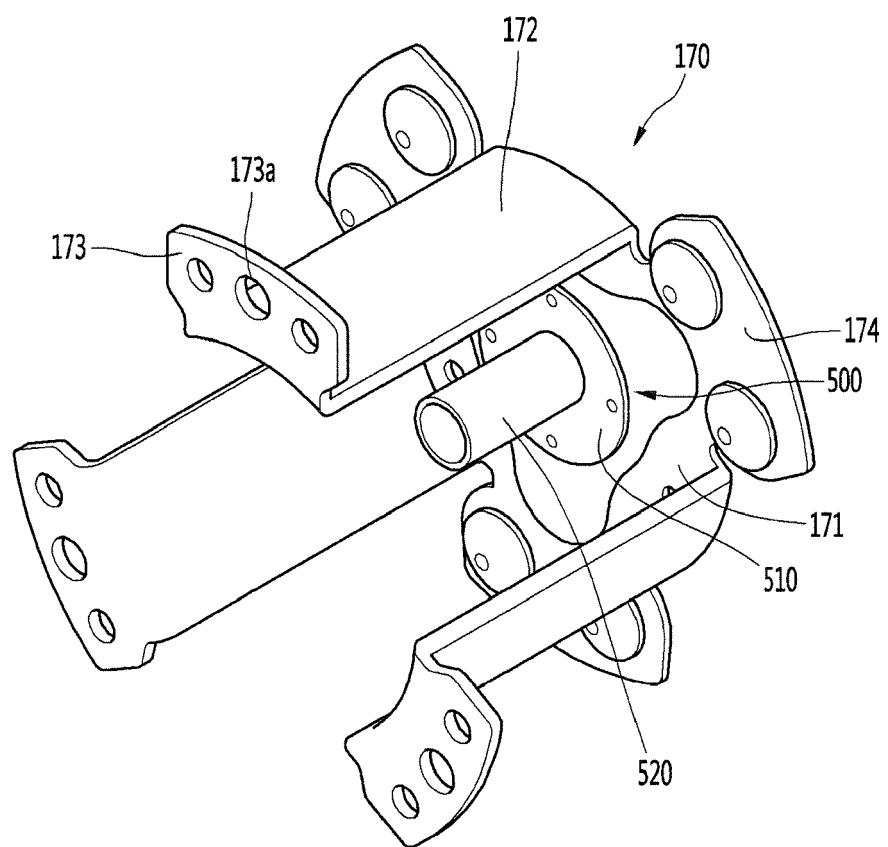
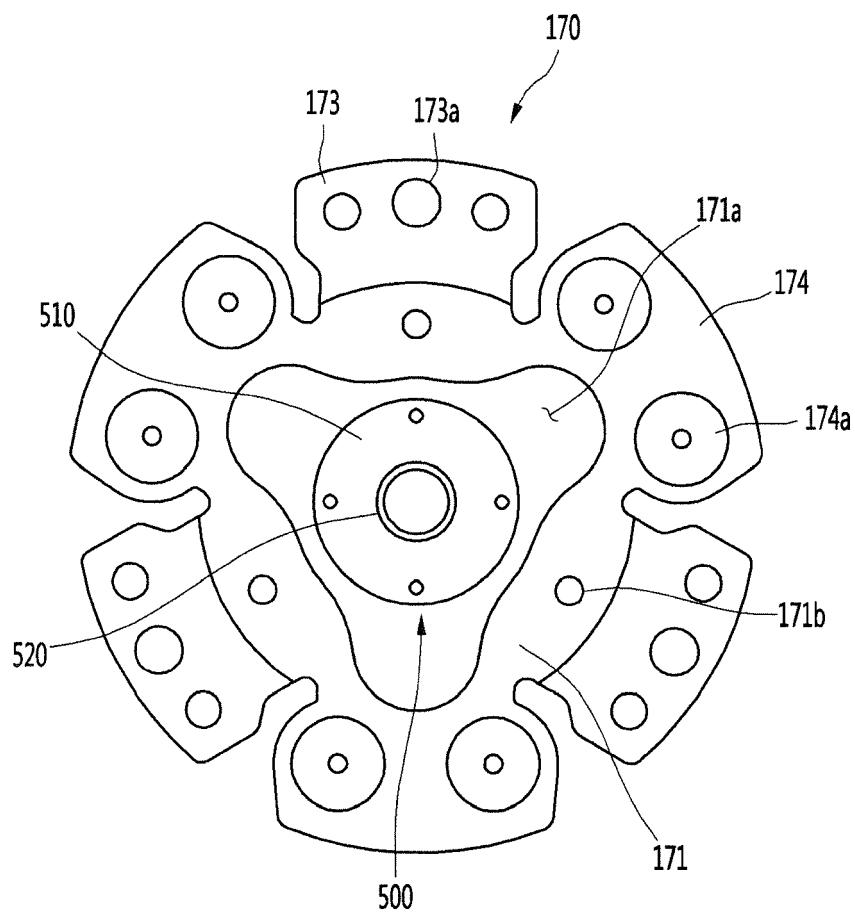


FIG. 9





EUROPEAN SEARCH REPORT

Application Number

EP 17 16 9046

5

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2015/004014 A1 (KIM JOOKON [KR] ET AL) 1 January 2015 (2015-01-01) * figures 1-3 * * paragraph [0028] - paragraph [0095] *	1-3 4-8, 11-13 9,10	INV. F04B35/04 F04B39/00
Y	-----		
X	US 2006/093498 A1 (KIM JEONG W [KR]) 4 May 2006 (2006-05-04) * figure 4 * * paragraph [0048] - paragraph [0067] *	1-3,9,10 11-13 4-8	
Y	-----		
A	-----		
X	WO 2007/046610 A1 (LG ELECTRONICS INC [KR]; KIM KWANG WOOK [KR]; SONG GYE YOUNG [KR]) 26 April 2007 (2007-04-26) * figure 1 * * paragraph [0050] - paragraph [0063] *	1-3,9,10 4-8, 11-13	
Y	-----		
A	-----		
Y	EP 2 975 267 A1 (LG ELECTRONICS INC [KR]) 20 January 2016 (2016-01-20) * figures 3-7 * * paragraph [0028] - paragraph [0071] *	4-7 1-3,8-13	
A	-----		
Y	EP 2 977 612 A1 (LG ELECTRONICS INC [KR]) 27 January 2016 (2016-01-27) * figures 1, 4, 9, 10 * * paragraph [0008] - paragraph [0035] * * paragraph [0062] - paragraph [0069] *	8 1-7,9-13	F04B
A	-----		
The present search report has been drawn up for all claims			
1	Place of search	Date of completion of the search	Examiner
50	Munich	11 September 2017	Ricci, Saverio
CATEGORY OF CITED DOCUMENTS			
55	X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document	T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 17 16 9046

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

11-09-2017

10	Patent document cited in search report	Publication date		Patent family member(s)	Publication date
15	US 2015004014 A1	01-01-2015	CN	104251196 A	31-12-2014
			CN	203906214 U	29-10-2014
			EP	2818710 A2	31-12-2014
20			EP	3093490 A1	16-11-2016
			US	2015004014 A1	01-01-2015
25	US 2006093498 A1	04-05-2006	CN	1769683 A	10-05-2006
			JP	4768387 B2	07-09-2011
			JP	2006132531 A	25-05-2006
			KR	20060039180 A	08-05-2006
30			US	2006093498 A1	04-05-2006
35	WO 2007046610 A1	26-04-2007	KR	20070042327 A	23-04-2007
			WO	2007046610 A1	26-04-2007
40	EP 2975267 A1	20-01-2016	CN	105298795 A	03-02-2016
			EP	2975267 A1	20-01-2016
45			KR	20160009306 A	26-01-2016
			US	2016017877 A1	21-01-2016
50	EP 2977612 A1	27-01-2016	CN	105275776 A	27-01-2016
			EP	2977612 A1	27-01-2016
55			US	2016017872 A1	21-01-2016

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- KR 1020140049403 [0006]